# Catapults and Platforms

## for Planetary Surface Exploration - Geology, Biomedicine & Astrobiology

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# Exploration Progression

INTEGRATIVE INTERROGATION

*Satellite observations, imaging, mapping, systematic scientific comparison with terrestrial and known lunar sites*

ENLIGHTENED RECONNAISSANCE

*Testing complex robotic (with/without humans) systems on the Moon before going to Phobos, Deimos, Mars, and otherwhere*

TIGHTLY TARGETED INQUIRY

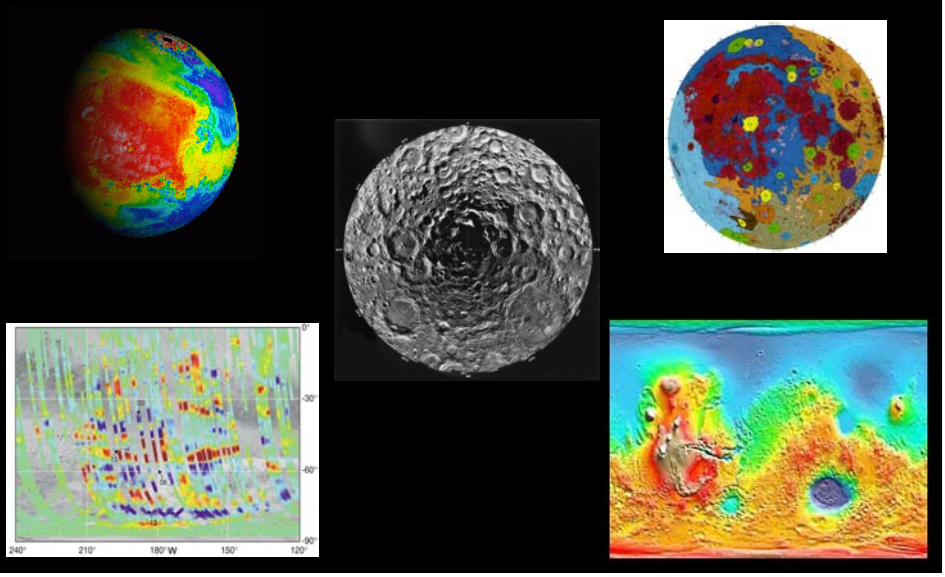
*Applying the investigative/integrative power of human explorers in concert with intelligent robots*

# Integrative Interrogation

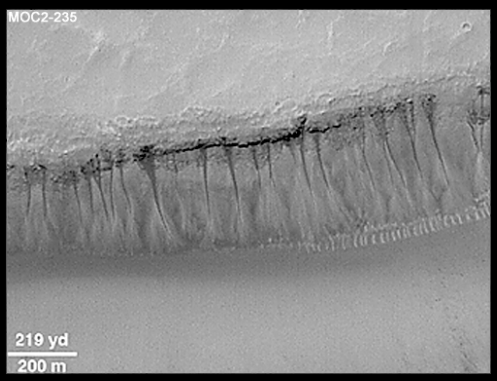
- Observe, map, and interpret planetary surfaces and processes - Earth, her Moon, Mars, Phobos, Deimos, Europa...
  - *Satellite images - Clementine, Viking, Galileo, Landsat, SPOT, Ikonos, Mars Global Surveyor (more detailed coverage for much of Mars than for most of Earth at present)...*
  - *Astronaut-acquired photos (>450,000 images, including stereophoto mapping suites; some taken specifically for comparison with lunar, martian images); SRTM data*
- Integrate relevant observations/interpretations; compare analogous data for the several planetary bodies
- From those integrated data, frame the seminal scientific questions (5 or fewer) to be addressed by robots and humans
- Select potential landing sites for maximum scientific yield, within the bounds of safety

# Observation & Mapping

*Lithic Units, Topography, Magnetic Signature, Thermal Spectra*



# Rock Layers and Seeps on Earth and Mars

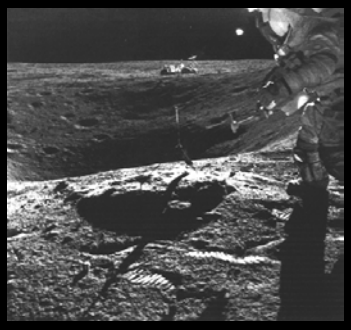




- Bahariya Oasis, Sahara - Layered strata, water seeps
- Analogous to interpreted seeps in Gorgonum Chaos?

# Enlightened Reconnaissance

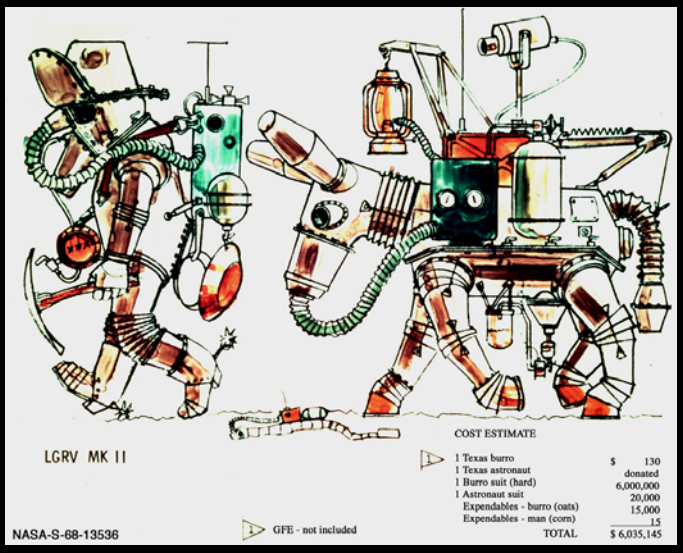
- Test telerobotic devices and complex robotic systems on the Moon before going to Phobos, Deimos, Mars, or other planetary bodies
- Determine strengths/limitations of candidate robots; develop specific technologies (EX/ER/EVA/SX experiments)
- Simulate Mars (etc.) exploration through experiments on the lunar far side (not telescopically visible; program a communication time lag) (Mendell, 2001)
- Drill to obtain the third spatial dimension, as well as the temporal (MESA proposal; Allen et al., 2001)
- Address [only] 1 or 2 critical scientific questions through well-focused robotic missions
- Use results to refine those questions for human/robotic missions

# Tightly Targeted Inquiry



- Apply the investigative/integrative power of human explorers in concert with intelligent robots
- *Any* result will address at least 1 critical question, with implications for more than one planetary body
- Expect Eureka! experiences, plan to accommodate them

# Surface Exploration Readiness



## Surface Exploration Readiness - 2

ASTRONAUT TRAINING IN

- Analogous planetary features and processes, image and map analysis
- Geological/astrobiological surface and subsurface sampling techniques, sample analysis
- Geophysical methods
- Developing predictive criteria (water, biotic remains)
- Biomedical and physical conditioning regimens to prepare for a progression of exploration tasks

## Surface Exploration Readiness - 3

COOPERATIVE PROJECTS WITH

- NASA-JSC and French Astrobiology Institutes - Briefings, field sampling, analytical exercises
- New Mexico Bureau of Geology - Geophysical methods, water exploration
- JSC space medics - Integrated physical conditioning and field exploration exercises
- JSC exploration, robotics and EVA engineers - Assessing execution of exploration tasks by robots and space-suited human

# A Human-Robotic Alliance

- Platform for analysis of a planetary surface, for crew physical conditioning, and for testing sample-handling devices in a microgravity environment
- Catapult for planetary exploration - not an end in itself!

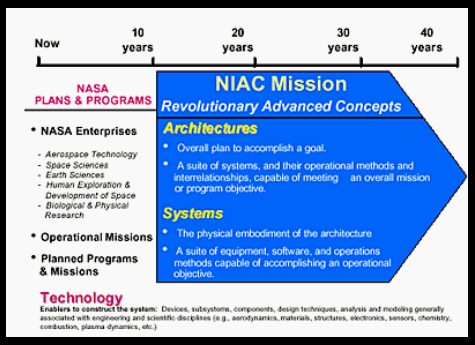
# New Efforts toward Planetary Science, Physical Conditioning, Sample Analysis Aboard ISS

Preflight field/classroom training in planetary analogues, image acquisition and interpretation
(Astronaut Office/Earth Sciences)

Pre-mission field training and post-mission physical and scientific tasks for ISS crews
(Space Medicine/Earth Sciences)

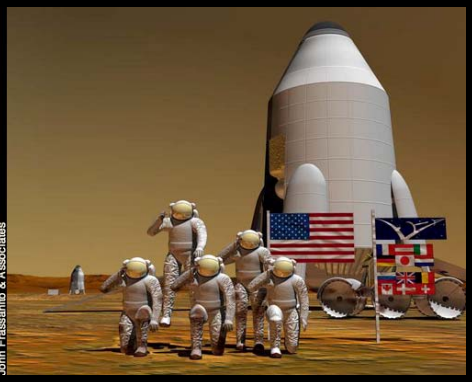
Robotic glovebox tests, sample preparation and manipulation
(Oceaneering Intl./Earth Sciences)

# Visionary Challenges

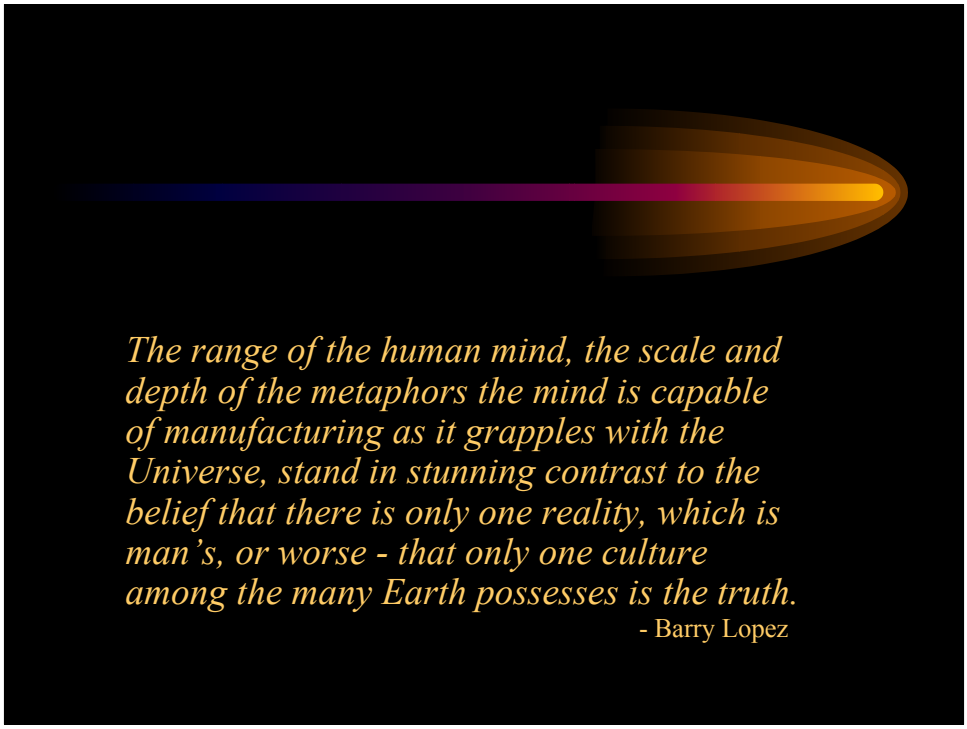



- Plan forty years out, prepare to fly within four.
- Both vision and focus are required.

# No Shortage of Vision




- New Mexico Institute of Technology initiative to establish a cooperative field training institute for planetary exploration
- Datalink Corporation offer of field communications network and a field training base


*The range of the human mind, the scale and depth of the metaphors the mind is capable of manufacturing as it grapples with the Universe, stand in stunning contrast to the belief that there is only one reality, which is man's, or worse - that only one culture among the many Earth possesses is the truth.*
- Barry Lopez